Docket No. 99-88CON1
PATENT

AMENDMENTS TO THE CLAIMS

Claim 1. (currently amended): A gas chromatograph having four or more analysis channels for simultaneous analysis of four or more fluid samples, the gas chromatograph ~~comprising~~comprising:

four or more gas chromatography columns, each of the four or more gas chromatography columns comprising an inlet for receiving a gaseous mobile phase that includes a gaseous sample, a separation media effective for separating at least one separated component of the gaseous sample from other components thereof, and an outlet for discharging the separated gaseous sample, and

a microdetector array comprising four or more microfabricated microdetectors integral with a substrate or with one or more microchip bodies mounted on the substrate, the four or more microdetectors having an inlet port in fluid communication with the outlet of one or more of the gas chromatography columns for receiving a separated gaseous sample, a detection cavity for detecting at least one separated component of the separated gaseous sample, and an outlet port for discharging the gaseous sample.

Claim 2. (original): The gas chromatograph of claim 1 wherein the four or more microdetectors each have a sensitivity for detecting a component of interest, the sensitivity varying less than about 10% between the four or more microdetectors.

Claim 3. (original): The gas chromatograph of claim 1 wherein the four or more microdetectors are integral with the substrate.

Claim 4. (withdrawn): The gas chromatograph of claim 1 wherein the four or more microdetectors are integral with one or more microchip bodies mounted on the substrate.

Claim 5. (withdrawn): The gas chromatograph of claim 4 wherein the one or more microchip bodies are detachably mounted on the substrate.

Claim 6. (previously presented): The gas chromatograph of claim 1 wherein the four or more microdetectors are selected from the group consisting of thermal conductivity microdetectors, photoionization microdetectors, optical emission microdetectors, flame ionization microdetectors, surface acoustic wave microdetectors and pulse discharge microdetectors.

Claim 7. (previously presented): The gas chromatograph of claim 1 wherein the four or more microdetectors are thermal conductivity microdetectors.

Claim 8. (previously presented): The gas chromatograph of claim 1 wherein the four or more microdetectors are thermal conductivity microdetectors, and each of the four or more thermal conductivity microdetectors comprise a detection cavity and a thin-film detection filament within the detection cavity.

Claim 9. (original): The gas chromatograph of claim 1 wherein the microdetectors are microfabricated in a plurality of silicon laminae using microfabrication techniques selected from the group consisting of oxidation, masking, etching, thin-film deposition, planarization and bonding.

Claim 10. (currently amended): A gas chromatograph having four or more analysis channels for simultaneous analysis of four or more fluid samples, the gas chromatograph ~~comprising~~comprising:

four or more gas chromatography columns, each of the four or more gas chromatography columns comprising an inlet for receiving a gaseous mobile phase that includes a gaseous sample, a separation media effective for separating at least one separated component of the gaseous sample from other components thereof, and an outlet for discharging the separated gaseous sample, and

a microdetector array comprising four or more thermal conductivity microdetectors for detecting the thermal conductivity of said at least one separated component of the gaseous sample, said thermal conductivity microdetectors being integral with or mounted on a substrate, each of the four or more thermal conductivity microdetectors having an inlet port in fluid

communication with the outlet of one or more of the gas chromatography columns for receiving a separated gaseous sample, a detection cavity, a thin-film detection filament within the detection cavity for detecting at least one separated component of the separated gaseous sample, and an outlet port for discharging the separated gaseous sample.

Claim 11. (previously presented): The gas chromatograph of claim 10 wherein the four or more thin-film detection filaments have a temperature-dependent resistance, and the four or more thermal conductivity microdetectors each have a thermal coefficient of resistance that varies less than about 10% between the four or more thermal conductivity microdetectors.

Claim 12. (previously presented): The gas chromatograph of claim 10 wherein the thin-film detection filament of each of the four or more thermal conductivity microdetectors has a resistance that varies less than about 25% between the four or more thermal conductivity microdetectors.

Claim 13. (original): The gas chromatograph of claim 10 wherein the thin-film detection filament comprises a film of material having a temperature-dependent resistance on a support bridge.

Claim 14. (previously presented): The gas chromatograph of claim 10 wherein the four or more thermal conductivity microdetectors are integral with the substrate.

Claim 15. (previously presented): The gas chromatograph of claim 14 wherein each of the four or more thermal conductivity microdetectors are formed in a substrate comprising one or more laminae and having an exterior surface, and the inlet port and outlet port of the thermal conductivity microdetectors each comprise an interior wall substantially normal to the exterior surface of the substrate.

Claim 16. (withdrawn): The gas chromatograph of claim 10 wherein the four or more thermal conductivity microdetectors are mounted on the substrate.

Claim 17. (cancelled)

Claim 18. (withdrawn): The gas chromatograph of claim 16 wherein the four or more thermal conductivity microdetectors are mounted individually on the substrate.

Claim 19. (withdrawn): The gas chromatograph of claim 16 wherein the four or more thermal conductivity microdetectors are mounted on the substrate as one or more modules, each of the one or more modules comprising two or more thermal conductivity microdetectors.

Claim 20. (withdrawn): The gas chromatograph of claim 16 wherein the four or more thermal conductivity microdetectors are integral with one or more microchip bodies mounted on the substrate, each of the one or more microchip bodies comprising one or more thermal conductivity microdetectors.

Claim 21. (withdrawn): The gas chromatograph of claim 16 wherein the four or more thermal conductivity microdetectors are integral with one or more microchip bodies bonded to the substrate, each of the one or more microchip bodies comprising one or more thermal conductivity microdetectors.

Claims 22-25. (cancelled)

Claim 26. (previously presented): The gas chromatograph of claim 10 wherein the each of the four or more thermal conductivity microdetectors further comprise first and second electrical contacts for electrical communication with an integral or an external signal-processing circuit, a first conductive path between the first electrical contact and a first end of the thin-film detection filament, and a second conductive path between the second electrical contact and a second end of the thin-film detection filament.

Claim 27. (previously presented): The gas chromatograph of claim 10 wherein the microdetector array further comprises at least one reference thermal conductivity microdetector, the at least one reference thermal conductivity microdetector having an inlet port in fluid communication with a reference gas source for receiving a reference gas, a detection cavity, a

thin-film detection filament within the detection cavity for detecting the reference gas, and an outlet port for discharging the detected reference gas, the ratio of the number of gaseous sample thermal conductivity microdetectors to the number of reference thermal conductivity microdetector(s) being at least 2:1.

Claim 28. (currently amended): The gas chromatograph of claim 10 wherein the four or more thermal conductivity microdetectors are arranged to have a planar density of at least about [[1]]one thermal conductivity microdetector per 10 cm^2.

Claim 29. (previously presented): The gas chromatograph of claim 10 wherein the four or more thermal conductivity microdetectors comprise six or more thermal conductivity microdetectors.

Claim 30. (currently amended): The gas chromatograph of claims 3 or 10 wherein the four or more thermal conductivity microdetectors comprise six or more thermal conductivity microdetectors arranged to have a planar density of at least about [[1]]one thermal conductivity microdetector per 1 cm^2.

Claim 31. (previously presented): The gas chromatograph of claims 3 or 10 wherein the volume of the detection cavity of each of the four or more thermal conductivity microdetectors ranges from about 1 μl to about 500μl.

Claim 32. (currently amended): A gas chromatograph for simultaneous analysis of six or more fluid samples, the gas chromatograph ~~comprising~~comprising:

six or more gas chromatography columns, each of the six or more gas chromatography columns comprising an inlet for receiving a gaseous mobile phase that includes a gaseous sample, a separation media effective for separating at least one separated component of the gaseous sample from other components thereof, and an outlet for discharging the mobile phase and the separated gaseous sample, and

a microdetector array comprising six or more sample thermal conductivity microdetectors and at least one reference thermal conductivity microdetector, each of the sample and reference thermal conductivity microdetectors being integral with or mounted on a substrate with a planar

density of at least about [[1]]<u>one</u> thermal conductivity microdetector per 1 cm^2, the ratio of sample thermal conductivity microdetectors to reference thermal conductivity microdetector(s) being at least 2:1,

each of the six or more sample thermal conductivity microdetectors having an inlet port in fluid communication with the outlet of one of the gas chromatography columns for receiving a separated gaseous sample, a detection cavity having a volume ranging from about 1 μl to about 500μl for detecting at least one component of the separated gaseous sample, a thin-film detection filament within the detection cavity, the thin-film detection filament having a temperature-dependent resistance, an outlet port for discharging the gaseous sample, a first conductive path between the a first end of the thin-film detection filament and a first electrical contact, and a second conductive path between a second end of the thin-film detection filament and a second electrical contact, the first and second electrical contacts being adapted for electrical communication with one or more integral or external signal-processing circuits,

the at least one reference thermal conductivity microdetector having an inlet port in fluid communication with a reference gas source for receiving a reference gas, a detection cavity, a thin-film detection filament within the detection cavity for detecting the reference gas, and an outlet port for discharging the detected reference gas,

the six or more sample thermal conductivity microdetectors each having a thermal coefficient of resistance that varies less than about 10% between the six or more thermal conductivity microdetectors.

Claim 33. (withdrawn): The gas chromatograph of claim 32 wherein the six or more sample thermal conductivity microdetectors are integral with one or more microchip bodies, each of the one or more microchip bodies comprising one or more thermal conductivity microdetectors, the microchip bodies being detachably mounted on a first mounting surface of the substrate, the first and second electrical contacts being situated on a first exposed surface of the microchip bodies, the first exposed surface of the microchip bodies being substantially parallel to a second mounting surface of the microchip bodies, the inlet port and the outlet port of the sample thermal conductivity microdetectors being substantially normal to the second mounting surface of the microchip bodies, the microdetector array further comprising

six or more pairs of passages formed in the substrate for fluid communication with the six or more thermal conductivity microdetectors, respectively, each pair of passages comprising a first inlet passage for fluid communication with the inlet port of one of the thermal conductivity microdetectors, and a second outlet passage for fluid communication with the outlet port of one of the thermal conductivity microdetectors,

one or more releasable seals situated between the first mounting surface of the substrate and the second mounting surface of the one or more microchip bodies,

one or more signal processing circuits for measuring the temperature-dependent resistance of each of the thin-film detection filaments, and

an array of electrical contact pins adapted to contact the electrical contacts at the first exposed surface of the one or more microchip bodies for providing electrical communication between the one or more signal processing circuits and the first and second electrical contacts of the six or more thermal conductivity microdetectors.

Claim 34. (original): The gas chromatograph of claim 10 further comprising a parallel injector, the parallel injector comprising one or more injection valves adapted to substantially simultaneous inject four or more gaseous samples into the respective mobile phase of the four or more gas chromatography columns.

Claim 35. (original): The gas chromatograph of claim 34 further comprising a parallel vaporizer, the parallel vaporizer comprising four or more injection ports for receiving four or more liquid samples, respectively, and four or more vaporization chambers for substantially simultaneously vaporizing four or more liquid samples to form the four or more gaseous samples.

Claim 36. (original): The gas chromatograph of claim 35 wherein the parallel vaporizer is integral with the parallel injector.

Claim 37. (previously presented): The gas chromatograph of claims 1, 10 or 32 wherein the four or more gas chromatography columns are capillary gas chromatography columns.

Claim 38. (previously presented): The gas chromatograph of claims 1, 10 or 32 wherein the four or more gas chromatography columns are microfluidic channels comprising the separation medium.

Claim 39. (original): The gas chromatograph of claims 1 or 10 wherein the gas chromatograph comprises eight or more gas chromatography columns in a heated environment, the heated environment comprising a convection zone for directed flow of a fluid in a substantially uniform direction past the eight or more gas chromatography columns.

Claim 40. (previously presented): The gas chromatograph of claims 7 or 10 wherein the detection cavity comprises two or more thin-film detection filaments.

Claim 41. (currently amended): The gas chromatograph of claims 1, 10 or 32 in an apparatus further ~~comprising~~comprising:

a parallel flow reactor having four or more reaction vessels, each of the four or more reaction vessels comprising an inlet for feeding reactants into the reaction vessel, a reaction zone for effecting a chemical reaction, and an outlet for discharging reaction products and unreacted reactants, if any, the outlets of the four or more reaction vessels being in at least sampling fluid communication with the inlets of the four or more gas chromatography columns, respectively.

Claim 42. (currently amended): A microdetector array ~~comprising~~comprising:

four or more thermal conductivity microdetectors integral with or mounted on a substrate with a planar density of at least about [[1]]one thermal conductivity microdetector per 10 cm^2, each of said thermal conductivity microdetectors ~~comprising~~comprising:

a detection cavity having a volume of not more than about 500 μl,

an inlet port for admitting a fluid sample into the detection cavity,

a thin-film detection filament within the detection cavity, the thin-film detection filament having a temperature-dependent resistance,

an outlet port for discharging a fluid sample from the detection cavity,

first and second electrical contacts for electrical communication with a signal-processing circuit,

a first conductive path between the first electrical contact and a first end of the thin-film detection filament, and

a second conductive path between the second electrical contact and a second end of the thin-film detection filament.

Claim 43. (previously presented): The array of claim 42 wherein the four or more thermal conductivity microdetectors each have a thermal coefficient of resistance that varies less than about 10% between the four or more thermal conductivity microdetectors.

Claim 44. (previously presented): The array of claim 42 wherein the thin-film detection filament of each of the four or more thermal conductivity microdetectors has a resistance that varies less than about 25% between the four or more thermal conductivity microdetectors.

Claim 45. (previously presented): The array of claim 42 wherein the four or more thermal conductivity microdetectors are integral with the substrate.

Claim 46. (withdrawn): The array of claim 42 wherein the four or more thermal conductivity microdetectors are mounted on the substrate.

Claim 47. (cancelled)

Claim 48. (withdrawn): The array of claim 46 wherein the four or more thermal conductivity microdetectors are integral with one or more microchip bodies mounted on the substrate, each of the one or more microchip bodies comprising one or more thermal conductivity microdetectors.

Claim 49. (withdrawn): The array of claim 46 wherein the four or more thermal conductivity microdetectors are integral with one or more microchip bodies bonded to the substrate, each of the one or more microchip bodies comprising one or more thermal conductivity microdetectors.

Claims 50-52. (cancelled)

Claim 53. (previously presented): The array of claim 42 wherein the four or more thermal conductivity microdetectors are arranged to have a planar density of at least about 1 thermal conductivity microdetector per 1 cm^2.

Claim 54. (previously presented): The array of claim 42 wherein the volume of the detection cavity of each of the four or more thermal conductivity microdetectors ranges from about 1 μl to about 500 μl.

Claim 55. (currently amended): A method for parallel analysis of four or more fluid samples by gas chromatography, the method ~~comprising~~comprising:

injecting four or more gaseous samples into respective mobile phases of four or more gas chromatography columns,

contacting the four or more gaseous samples with separation media in the respective gas chromatography columns to separate at least one analyte from other constituents of the gaseous samples, and

detecting the four or more separated analytes with a microdetector array comprising four or more microfabricated thermal conductivity microdetectors.

Claim 56. (currently amended): A method for using the gas chromatograph of any of claims 1, ~~5,~~ 7 or 8 for parallel analysis of four or more fluid samples by gas chromatography, the method ~~comprising~~comprising:

injecting four or more gaseous samples into respective mobile phases of the four or more gas chromatography columns,

contacting the four or more gaseous samples with separation media in the respective gas chromatography columns to separate at least one analyte from other constituents of the gaseous samples, and

detecting the four or more separated analytes with the microdetector array.

Claim 57. (currently amended): A method for using the gas chromatograph of any of claims 1, 10 or 32 for parallel analysis of four or more fluid samples by gas chromatography, the method ~~comprising~~comprising:

injecting four or more gaseous samples into respective mobile phases of the four or more gas chromatography columns,

contacting the four or more gaseous samples with separation media in the respective gas chromatography columns to separate at least one analyte from other constituents of the gaseous samples, and

detecting the four or more separated analytes with the microdetector array.

Claim 58. (currently amended): The method of claim 55 wherein the four or more fluid samples are four or more liquid samples, the method further ~~comprising~~comprising:

injecting the four or more liquid samples into the injection ports of the parallel vaporizer, and

substantially simultaneously vaporizing the four or more liquid samples to form four or more gaseous samples.

Claim 59. (original): The method of claim 55 wherein the four or more fluid samples are four or more gaseous samples discharged from a parallel flow reactor comprising four or more reaction channels.

Claim 60. (currently amended): A method for using the gas chromatograph of claims 1, 10 or 32 for evaluating the catalytic performance of candidate catalysts, the method ~~comprising~~comprising:

simultaneously contacting four or more candidate catalysts with one or more reactants in a parallel reactor under reaction conditions to catalyze at least one reaction, and

detecting the resulting reaction products or unreacted reactants in parallel with the gas chromatograph to determine the relative performance of the candidate catalysts.

Claim 61. (previously presented): The method of claim 60 wherein the four or more candidate catalysts have different compositions.

Claim 62. (previously presented): The method of claim 60 wherein the four or more candidate catalysts are contacted with the one or more reactants under different reaction conditions.

Claim 63. (currently amended): A gas chromatograph having eight or more analysis channels for simultaneous analysis of eight or more fluid samples, the gas chromatograph ~~comprising~~comprising:

eight or more gas chromatography columns residing in a heated environment, each of the eight or more gas chromatography columns comprising an inlet for receiving a gaseous mobile phase that includes a gaseous sample, a separation media effective for separating at least one separated component of the gaseous sample from other components thereof, and an outlet for discharging the separated gaseous sample, the heated environment comprising a forced convection zone for directed flow of a fluid in a substantially uniform direction past the eight or more gas chromatography columns, and

a microdetector array comprising eight or more thermal conductivity microdetectors, the eight or more microdetectors each having an inlet port in fluid communication with the outlet of one or more of the gas chromatography columns for receiving a separated gaseous sample, a detection cavity for detecting at least one separated component of the separated gaseous sample, and an outlet port for discharging the separated gaseous sample.

Claim 64. (original): The gas chromatograph of claim 63 wherein the convection zone is defined by a zone of substantially uniformly directed turbulent fluid flow between two or more convection fans.

Claim 65. (original): The gas chromatograph of claim 63 wherein the convection zone is defined by a zone of substantially uniformly directed turbulent fluid flow created by two or more convection fans on opposing sides of the eight or more gas chromatography columns.

Claim 66. (original): The gas chromatograph of claim 65 wherein the convection zone is further defined by a chimney adapted to direct the fluid flow within the chimney from one or

more convection fans on first side of the eight or more gas chromatography columns to one or more opposing convection fans on an opposing second side of the eight or more gas chromatography columns, with the gas chromatography columns being internal or external to the chimney.

Claim 67. (original): The gas chromatograph of claim 66 wherein a first convection fan is a radial convection fan and a second convection fan is an axial convection fan.

Claim 68. (original): The gas chromatograph of claim 63 comprising sixteen or more gas chromatography columns in the heated environment.

Claim 69. (currently amended): The gas chromatograph of claim 3 wherein the four or more thermal conductivity microdetectors comprise six or more thermal conductivity microdetectors arranged to have a planar density of at least about [[1]]<u>one</u> thermal conductivity microdetector per 1 cm^2.

Claim 70. (previously presented): The gas chromatograph of claim 3 wherein the volume of the detection cavity of each of the four or more thermal conductivity microdetectors ranges from about 1 μl to about 500 μl.

Claim 71. (previously presented): The gas chromatograph of claim 1 wherein the four or more gas chromatography columns are capillary gas chromatography columns.

Claim 72. (previously presented): The gas chromatograph of claim 1 wherein the four or more gas chromatography columns are microfluidic channels comprising the separation medium.

Claim 73. (previously presented): The gas chromatograph of claim 1 wherein the gas chromatograph comprises eight or more gas chromatography columns in a heated environment, the heated environment comprising a convection zone for directed flow of a fluid in a substantially uniform direction past the eight or more gas chromatography columns.

Claim 74. (previously presented): The gas chromatograph of claim 7 wherein the detection cavity comprises two or more thin-film detection filaments.

Claim 75. (currently amended): The gas chromatograph of claim 1 in an apparatus further ~~comprising~~comprising:

a parallel flow reactor having four or more reaction vessels, each of the four or more reaction vessels comprising an inlet for feeding reactants into the reaction vessel, a reaction zone for effecting a chemical reaction, and an outlet for discharging reaction products and unreacted reactants, if any, the outlets of the four or more reaction vessels being in at least sampling fluid communication with the inlets of the four or more gas chromatography columns, respectively.

Claim 76. (currently amended): A method for using the gas chromatograph of claim 1 for evaluating the catalytic performance of candidate catalysts, the method ~~comprising~~comprising:

simultaneously contacting four or more candidate catalysts with one or more reactants in a parallel reactor under reaction conditions to catalyze at least one reaction, and

detecting the resulting reaction products or unreacted reactants in parallel with the gas chromatograph to determine the relative performance of the candidate catalysts.

Claim 77. (previously presented): The method of claim 76 wherein the four or more candidate catalysts have different compositions.

Claim 78. (previously presented): The method of claim 76 wherein the four or more candidate catalysts are contacted with the one or more reactants under different reaction conditions.

Claim 79. (previously presented): The gas chromatograph of claim 32 wherein the six or more gas chromatography columns are capillary gas chromatography columns.

Claim 80. (previously presented): The gas chromatograph of claim 32 wherein the six or more gas chromatography columns are microfluidic channels comprising the separation medium.

Claim 81. (currently amended): The gas chromatograph of claim 32 in an apparatus further ~~comprising~~comprising:

a parallel flow reactor having six or more reaction vessels, each of the six or more reaction vessels comprising an inlet for feeding reactants into the reaction vessel, a reaction zone for effecting a chemical reaction, and an outlet for discharging reaction products and unreacted reactants, if any, the outlets of the six or more reaction vessels being in at least sampling fluid communication with the inlets of the six or more gas chromatography columns, respectively.

Claim 82. (currently amended): A method for using the gas chromatograph of claim 32 for parallel analysis of six or more fluid samples by gas chromatography, the method ~~comprising~~comprising:

injecting six or more gaseous samples into respective mobile phases of the six or more gas chromatography columns,

contacting the six or more gaseous samples with separation media in the respective gas chromatography columns to separate at least one analyte from other constituents of the gaseous samples, and

detecting the six or more separated analytes with the microdetector array.

Claim 83. (currently amended): A method for using the gas chromatograph of claim 32 for evaluating the catalytic performance of candidate catalysts, the method ~~comprising~~comprising:

simultaneously contacting six or more candidate catalysts with one or more reactants in a parallel reactor under reaction conditions to catalyze at least one reaction, and

detecting the resulting reaction products or unreacted reactants in parallel with the gas chromatograph to determine the relative performance of the candidate catalysts.

Claim 84. (previously presented): The method of claim 83 wherein the six or more of candidate catalysts have different compositions.

Claim 85. (previously presented): The method of claim 83 wherein the six or more candidate catalysts are contacted with the one or more reactants under different reaction conditions.

[No Further Amendments This Page]